

THAT WHICH IS CLAIMED IS:

1. A method for forming an ohmic contact to silicon carbide (12) for a semiconductor device, the method comprising:

implanting at room temperature a selected dopant material into a surface of a silicon carbide substrate (12) thereby forming a layer (16) on the silicon carbide substrate having an increased concentration of dopant material;

annealing the implanted silicon carbide substrate a first time;

growing at least one epitaxial layer of a compound other than SiC that dissociates below the dissociation temperature at SiC (14) on the silicon carbide substrate opposite the implanted surface;

depositing a layer of metal (18) on the implanted surface of the silicon carbide substrate (12); and thereafter

annealing the metal (18) and the implanted silicon carbide substrate (12, 16) a second time at a temperature below that at which significant degradation of the compound forming the epitaxial layer (14) would occur, but high enough to form an ohmic contact between the implanted silicon carbide (12, 16) and the deposited metal.

2. A method according to claim 1 wherein the step of growing the epitaxial layer (14) on the silicon carbide substrate (12) precedes the first annealing of the implanted silicon carbide substrate (12).

3. A method according to claim 1 wherein the step of growing the epitaxial layer (14) on the silicon carbide substrate (12) follows the first annealing of the implanted silicon carbide substrate (12).

4. A method according to claim 1 wherein the selected dopant material is selected from the group consisting of nitrogen, aluminum, arsenic, phosphorous, boron and gallium.

5. A method according to claim 1 wherein the first annealing the implanted silicon carbide substrate (12, 16) occurs at a temperature above 1000°C to 1300°C.

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6. A method according to claim 1 wherein the metal (18) is selected from the group comprising nickel, palladium, platinum, aluminum and titanium.

5 7. A method according to claim 1 wherein the step of annealing the silicon carbide substrate (12) and the deposited metal (18) occurs at a temperature below 850°C.

8. A semiconductor device (10) comprising:  
a semiconductor substrate (12) having a first surface and a second surface and  
10 a first conductivity type;  
at least one epitaxial layer (14) on said first surface of said semiconductor substrate (12), said epitaxial layer formed of a material with a dissociation temperature below that of the semiconductor substrate;  
a zone (16) of increased carrier concentration in said semiconductor substrate  
15 (12) and extending from said second surface of said semiconductor material toward said first surface; and  
a layer of metal (18) deposited on said second surface of said semiconductor substrates (12) that forms an ohmic contact at the interface (20) of said metal and said zone (16) of increased carrier concentration.

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9. A semiconductor device according to claim 8 wherein the semiconductor substrate (12) is silicon carbide.

25 10. A semiconductor device according to claim 8 wherein the implanted dopant material is selected from the group consisting of nitrogen, aluminum, arsenic, phosphorous, boron and gallium.

11. A semiconductor device according to claim 9 wherein the initial carrier concentration in the silicon carbide is between  $1 \times 10^{15}$  to  $1 \times 10^{19} \text{ cm}^{-3}$ .

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12. A semiconductor device according to claim 11 wherein the carrier concentration in the zone of increased carrier concentration (16) is between  $1 \times 10^{18}$

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and  $1 \times 10^{20} \text{ cm}^{-3}$  and is greater than the initial carrier concentration in the silicon carbide.

13. A semiconductor device according to claim 8 wherein said epitaxial layers  
5 (14) are selected from the group consisting of gallium nitride; aluminum gallium nitride; indium gallium nitride; and oxides of silicon, gallium, aluminum and indium.

14. A semiconductor device according to claim 9 wherein said metal (18) is  
10 selected from the group comprising nickel, palladium, platinum, aluminum and titanium.

15. A semiconductor device (10) comprising:  
a silicon carbide substrate (12) having a first surface and a second surface and  
an initial concentration of dopant imparting an initial conductivity type;  
15 at least one epitaxial layer (14) on said first surface of silicon carbide substrate (12);  
a zone of increased carrier concentration (16) in said silicon carbide substrate (12) and extending from said second surface of said silicon carbide substrate (12)  
toward said first surface, said zone of dopant material (16) being characterized by a  
20 concentration of dopant that progressively decreases from said second surface toward said first surface; and  
a nickel ohmic contact (18) on said second surface of said silicon carbide substrate (12).

25 16. A semiconductor device according to claim 15 wherein the implanted dopant material is selected from the group consisting of nitrogen, aluminum, arsenic, phosphorous, boron and gallium.

30 17. A semiconductor device according to claim 15 wherein the initial carrier concentration in the silicon carbide is between  $1 \times 10^{15}$  to  $1 \times 10^{19} \text{ cm}^{-3}$ .

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18. A semiconductor device according to claim 17 wherein the carrier concentration in the zone of increased carrier concentration is between  $1 \times 10^{18}$  and  $1 \times 10^{20} \text{ cm}^{-3}$  and is greater than the initial carrier concentration in the silicon carbide.

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19. A semiconductor device according to claim 15 wherein said epitaxial layers (14) are selected from the group consisting of gallium nitride; aluminum gallium nitride; indium gallium nitride; and oxides of silicon, gallium, aluminum and indium.

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20. A semiconductor device according to claim 15 wherein the semiconductor device is a vertical device.